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[No. 18]

SUBCOMMITTEE HEARING ON H. R. 3377, CONSTRUCTION OF AERONAUTICAL RESEARCH FACILITIES BY NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE NO. 3,
Washington, D. C., Thursday, March 7, 1957.

The subcommittee met at 10 a. m., Hon. Carl T. Durham (chairman of the subcommittee) presiding.

Mr. DURHAM. The committee will come to order.

The meeting this morning is to hear the NACA on their request for authorization.

(The bill is as follows:)

[H. R. 3377, 85th Cong., 1st sess.]

A BILL To promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, pursuant to subsection (b) of section 1 of Public Law 672, approved August 8, 1950 (50 U. S. C. 151b), the National Advisory Committee for Aeronautics is authorized to undertake additional construction and to purchase and install additional equipment at the following locations:

Langley Aeronautical Laboratory, Hampton, Virginia: High-speed leg for the unitary plan tunnel, hypersonic physics test area, data reduction center, improved air supply, modification of an existing tunnel, central heating system, hypersonic tunnel, and an approach road, $8,164,000.

Ames Aeronautical Laboratory, Moffett Feld, California: Hypersonic tunnel, improvements to the unitary plan tunnel, and a boundary-layer removal system for the fourteen-foot transonic tunnel, $16,521,000.

Lewis Flight Propulsion Laboratory, Cleveland, Ohio: Modifications to the component research facility for nuclear propulsion, expansion of the propulsion systems laboratory, rocket systems research facility, and acquisition of not to exceed one hundred and fifteen acres of land, $17,455,000.

Pilotless aircraft station, Wallops Island, Virginia: Modernization of instrumentation, $2,560,000.

SEC. 2. Any of the approximate costs enumerated in section 1 of this Act may, in the discretion of the Director of the National Advisory Committee for Aeronautics, be varied upward 5 per centum to meet unusual cost variations, but the total cost of all work so enumerated shall not exceed $44,700,000.

SEC. 3. Any funds appropriated for the construction of facilities pursuant to this Act may, with the approval of the Bureau of the Budget, be used for emergency repairs of existing facilities when (1) such existing facilities are made inoperative by major breakdown, accident, or other circumstance; and (2) such repairs are deemed by the Chairman of the National Advisory Committee for Aeronautics to be of greater urgency than the construction of new facilities.

SEC. 4. There are hereby authorized to be appropriated such amounts as may be required to accomplish the purposes of this Act.

Mr. DURHAM. Dr. Dryden, we are glad to have you back with us again and see you looking so well.

Dr. DRYDEN. Thank you, sir. I will follow a statement which you have in front of you, with some interpolations, Mr. Chairman.

Mr. DURHAM. All right, Doctor, you may proceed.

Dr. DRYDEN. It is a privilege to appear before this committee again to discuss the proposed aeronautical research facilities construction program of the National Advisory Committee for Aeronautics.

The airplane, the missile, and the atomic fission and fusion bombs have changed concepts of military power and the course of history. Our competitor is making a tremendous effort to surpass us; her technology, her scientific manpower, and her stockpile of modern weapons have made great strides. I believe that the quality of our weapons taken as a whole is ahead, but the gap is rapidly closing.

Our national security depends on an adequate number of airplanes and missiles of superior performance. Numbers alone are insufficient unless their performance is at least equal to those our skilled airmen may be called upon to oppose. It is the task of the aeronautical laboratories not only to provide the new ideas necessary to insure superior performance, but at the same time to prove in advance the soundness of the design as a whole. The NACA's work, therefore, falls into two principal categories: (1) Research to furnish new ideas; and I might say, if time were available, I could run through many ideas of recent years, which have found expression in our modern airplanes and given them capabilities, which we believe, as I have mentioned, puts us ahead of our competitors.

And, second, the application of new ideas to current military designs in cooperation with industry.

To advance the frontiers of speed, altitude, and range, special research facilities are required.

This committee some years ago provided us with facilities to enter the supersonic range with speeds up to five times the speed of sound. These facilities are now in operation on our current supersonic program providing research data for the supersonic airplanes of the immediate future.

The step beyond this, which again I would be glad to discuss with you off the record, at some time, so that we can speak freely, the speeds beyond this are speeds above five times the speed of sound; one way of expressing it is from the speed of the V–2 missile all the way up to the speed of the ballistic missile and the satellite vehicles.

As you know, we are entering this area in the missile field. I am enough of an optimist to believe we will also enter this area with manned airplanes. In fact, I will express my faith that we will not be happy until we have men on satellites, but I don't believe I will be here myself to see that.

Mr. DURHAM. We hope so.

Dr. DRYDEN. Until recently we have had insufficient knowledge to reproduce the conditions of high speed and temperature experienced in hypersonic flight. We have had to be content with small-scale exploration of many ideas. We know now how to proceed with pilot facilities and in some cases with larger facilities which will give results immediately applicable in design.

H. R. 3377 reflects NACA's urgent need for additional facilities for research in the hypersonic speed range, and the continuing need for modernizing existing facilities for the solution of new problems in the

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subsonic, transonic, and supersonic speed ranges. The 1958 construction program totals $44,700,000, summarized as follows:

New facilities for hypersonic research	$20,965,500
Expansion of facilities for nuclear research	5,655,000
Modernization of research facilities	10,936,400
Modernization of supporting technical facilities	6,485,200
General plant and utility improvements	657,900
Total	44,700,000

Hypersonic research is a relatively new field. The remaining part of the program is very similar to what you hear from us every year. We have a plant whose cost, that is, the sum of appropriations invested in it, is about $325 million. Its reproduction cost is probably closer to $500 million. As many of you know, it is a highly complex plant. It includes motors that produce up to 250,000 horsepower in a single tunnel, drying equipment, heating equipment, and all of the mechanical devices necessary to do research in this complex technological field.

And it takes a certain sum just to keep things current with the advances in the art. Half of this request is to get the tools to carry the work forward in this hypersonic area. The rest is to modernize the plant that we have.

Now, to take up these facilities in some detail. Under the facilities for hypersonic research, the first item is the construction of a 3.5-foot hypersonic tunnel. Hypersonic means in general the range of speeds above five times the speed of sound.

As I will mention in a moment, in a wind tunnel, the limit we can reach so far as our present knowledge goes is something of the order of 10 times the speed of sound, using the air through which airplanes and missiles fly.

Mr. DURHAM. The equipment you have—pardon me, Doctor—the equipment you have at the present time in supersonic wind tunnels carries you up to a mach number of 5?

Dr. DRYDEN. Yes, for large scale work, and we have some small pilot equipment which gets into this range up to 10 very tiny models. The construction of a 3.5-foot hypersonic tunnel at the Ames Aeronautical Laboratory is proposed to investigate the aerodynamics of aircraft capable of steady level flight at hypersonic speeds. The proposed facility will be capable of duplicating flight Reynolds numbers at Mach numbers from 5 to 10, and flight temperatures at flight Reynolds numbers at a Mach number of 5. The Reynolds number is a measure of the size of the model; by increasing the Reynolds number by changing the density of the air, we can reproduce flight conditions. So when we say the tunnel duplicates flight Reynolds numbers, it means it can duplicate conditions so that the results are immediately applicable to flight conditions. The tunnel will accommodate models large enough to permit the scaled duplication of aircraft structural components so that detailed studies can be made of aerodynamic heating on the aerodynamic characteristics of hypersonic aircraft as they occur in flight.

As you gentlemen know, aerodynamic heating is one of the foremost problems encountered in flight at hypersonic speeds. The success or failure of a hypersonic aircraft may well depend on how it reacts to the temperatures and hearing rates encountered in flight. At present,

the design of such vehicles would have to proceed without detailed knowledge of their aerodynamic characteristics since much of the needed design information is not available. This proposed tunnel is designed to provide detailed and integrated studies of all required aerodynamic characteristics under conditions comparable to those that would be encountered in flight.

"Aerodynamic characteristics" is a term that lumps all together how much lift the wings give, what the drag is that opposes the motion, how to control the airplane or missile and the factors determining its stability. All that we mean by the term "aerodynamic characteristics."

The tunnel will duplicate flight Reynolds numbers and flight air temperatures so that the details of convective heat-transfer to a vehicle may be studies under conditions corresponding to those that would be encountered in flight.

Heat transfer is another technical term. It is the heat that comes from the friction of the air, just as a meteor travels fast and burns up, so an airplane traveling fast will get hot. We can't afford to let it burn up. We have to deal with this heat which comes from the motion. Since the nozzle walls of this facility remain cool, the heat radiation from the model surface will approximate that experienced by an aircraft at hypersonic speeds and the counterbalancing effects of convective and radiative heat transfer—that is, the heating up of the friction and the loss of heat by radiation—can be observed as they would occur in flight.

That, again, is a slightly technical point. You know if you heat a poker red hot you can feel the heat coming from the poker to your face. So you can get rid of a certain amount of heat on an airplane by permitting the surface temperature to be raised to red heat.

It can then lose heat by radiation. That is part of the cooling, which means you don't have to provide so much in other ways. This tunnel will reproduce radiation of heat from the models to the cool surface of the tunnel walls, which in real flight would be the cold space around the airplane.

The proposed tunnel will also be used to study the overall aspects of convective heating for a complete configuration. In this connection, an analysis has been made which demonstrates that a wind tunnel can simulate the heating histories of vehicles in level flight in essentially the same manner that the atmospheric-entry simulator reproduces the heating histories of ballistic-type vehicles.

Last year you provided us with a device which permits us to simulate on a very small scale the entry of a ballistic missile nose in the atmosphere. It is done by shooting a missile down a wind tunnel of very special shape.

The simulation requires that flight Mach numbers, stream temperatures, and Reynolds numbers be duplicated, and that the essential components of a vehicle be reproduced in scale. A one-tenth scale model tested in the wind tunnel for 1 minute would simulate the heating experienced by a full-scale vehicle in a flight at a Mach number of 5 over a distance of about 6,000 miles.

In summary, the designer of hypersonic aircraft is confronted with difficult problems in the fields of aerodynamic heating, stability, control, and performance which can be solved only with the aid of detailed and accurate data from tests which duplicate actual flight conditions.

Much of the required data could be obtained in the proposed tunnel. The facility will provide test Mach numbers of 5, 7, and 10 at each of these Mach numbers typical flight Reynolds numbers will be duplicated. The duplication will be adequate for the study of many hypersonic design problems, particularly those of performance and control. The facility will also be capable of operation at stagnation temperatures up to 2,000 degrees F. at all Mach numbers.

The second facility proposed for basic hypersonic research in the speed range above 10 times the speed of sound is a helium blowdown tunnel. That means a tunnel which uses helium gas instead of air. Experimental rocket-propelled vehicles are attaining speeds in excess of those which can be studied in existing experimental facilities.

I think it has been announced that we have fired models up to 10 times the speed of sound and we have done somewhat better than that since then.

The current earth satellite program and military plans for long-range missiles point up the actual need for greater information on phenomena which occur at speeds attainable in outer space. There is no wind tunnel available for testing at Mach numbers much above 10 and I think I mentioned before the likelihood of an air tunnel achieving Mach numbers much in excess of this appears remote because of the extreme pressures and temperatures required for air.

An analysis of the potentialities of helium as a test medium has shown it to be highly suitable for hypersonic research at speeds far above the capabilities of air tunnels. The practicality of a helium tunnel has also been experimentally demonstrated on a very small scale. While helium does not permit exact simulation of flow conditions for air, for purposes of basic fluid mechanics research, the difference is of little consequence.

The proposed hypersonic blowdown tunnel will use helium as a test medium and will be capable of operating at Mach numbers from 10 to 25.

The helium tunnel, like many of our wind tunnels, will be a closed circuit tunnel, a closed tank, so we will not be blowing helium out in the air at a great rate. We will circulate helium through a closed system.

The project entitled "High Speed Leg for the Unitary Plan Tunnel" covers construction of two fixed nozzles previously included as part of the project approved in the fiscal year 1957 construction program. The nozzles had to be deleted to live within the reduced appropriation provided for the project. The project as now contemplated will cover the Mach number range between 10 and 12.

These facilities cover the aerodynamic or airflow side of the problems of hypersonic flight. There is also the propulsion and structural side.

The rocket systems research facility project at the Lewis Flight Propulsion Laboratory proposes the construction of two new buildings and the alteration of an existing building to provide research stands, cells, and laboratories.

The increasing application of rocket powerplants and the use of new propellants has brought new and pressing problems in controls, pumping, and the interferences caused by close coupling of multiple-engine systems. In long-range ballistic missiles, these problems are greatly accentuated. Making sure that the missile is directionally on its proper course is only part—that is, points in the right direction—

of the problem; in addition you have to make sure that the missile is traveling at precisely the right speed when the rocket motor burns out. Otherwise, of course, the target will be overshot or undershot. Single rocket engines, each with thrusts much greater than that of present turbojet engines, must be operated together.

The rocket motor of the V–2 burned for about 70 seconds. Purely for illustration—and I emphasize this is not any missile engine, let's say the burning time of one concept of an ICBM might be about 3 times that, some 200 seconds. During that time—3½ minutes—the fuel and oxidant might be pumped into the combustion chamber at the rate of about a ton a second.

Calculations indicate that if the missile is going to destroy a priority target the rocket motor must operate with a degree of precision which has not been used before in devices of this size or complexity. In 5 minutes a missile must reach an altitude of 500,000 to 1 million feet, traveling at a velocity of 18,000 miles per hour. If the velocity is 18,005 miles per hour, it misses the target by 5 miles. Likewise, if 1 percent of the propellant isn't used, the miss may be measured in hundreds of miles.

So that the control on the consumption of fuel and getting the whole thing burned in the exact amount of time is a tremendously difficult technical problem. If we are going after really high accuracy in ballistic missiles we have to solve problems of a difficulty that has not been experienced so far.

Pumps for rocket propellants must operate under severe conditions, such as with surging inlet pressure due to boiling of the fluids being handled. Turbines and their gas generators for driving the pumps must be adapted to use the same propellants as the main rocket combustion chamber to avoid the need for separate tanks and flow systems. The proposed facility will be equipped to handle inert fluids such as water and liquid nitrogen for research on flow funadmentals, as well as liquid rocket propellants.

The design of the bearings and seals used in the liquefied gas pumps require studies in a new field involving unfamiliar phenomena that have not been significant in usual bearing applications. Among these phenomena are extreme dangers from leaks in bearings and seals, handling fluids hostile to lubricants and lubrication, and lubrication at temperatures as low as that of boiling hydrogen (−424° F.)

I would like to emphasize what we are talking about in this facility is the same kind of support—basic and applied research support—for the development of this type of powerplant, as we carry on for turbojets, and ram jets.

We ourselves are not developing hardware for specific missiles, pumps and turbines, and so on. But we study the problems which arise in their design, to improve them, and to make them more reliable in performance. This proposed new facility will make possible research on these and many other rocket problems.

Turbopump research will be directed at providing pumps and turbines that are operable with boiling and corrosive fluids, that deliver large flow rates and high pressures, that have suitable suction characteristics, and that have maximum efficiencies and minimum size and weight. Controls research will have the objectives of accurately controlling the rocket thrust-time relationship, accurately monitoring propellant consumption, obtaining desired fluid flow-pressure-time

sequence in the turbopump, and providing a reliable system that operates smoothly, without pulsation, vibration damage, or malfunctioning. Bearing and seal research will be directed at developing bearings and seals which will operate satisfactorily and reliably in corrosive and low viscosity fluids, and at very high as well as at very low temperatures.

That is the propulsion side of the new hypersonic facilities. We also have a difficult problem in materials research at high temperatures.

Research on materials, structures, and aerodynamics at elevated temperatures requires the investigation of problems at all points along the Mach number and temperature scales up to Mach numbers of 20 or more. Experimental equipment and facilities suitable for such investigations, as well as the problems themselves, differ greatly in nature as the speeds and temperatures increase. The development of large-scale devices capable of producing extremely high temperature and at the same time capable of representing correctly other environmental conditions such as speed, gas, chemistry, and time durations has not yet been accomplished satisfactorily. For this reason, NACA seeks on a small scale to try ideas for accomplishing such developments while at the same time utilizing for limited research the equpiment produced for such trials.

The proposed hypersonic physics test area is designed to facilitate progress in the general area of equipment and technique development in the higher temperature ranges while at the same time providing safe and integrated means for conducting exploratory research at these temperatures. The facilities proposed for the test area include chemical jets providing temperatures up to nearly 11,000° F. The one most familiar to you, is the exhaust from an ordinary rocket. This is a very hot, extreme high speed jet resulting from burning the rocket fuels. By burning certain special chemicals we can get temperatures which are higher. By this means we provide a relatively fast air stream of perhaps a few times the speed of sound, but at very high temperatures, to study heat transfer problems.

The other way to develop high speed is to develop guns that will shoot small models at very high speeds. The hyper velocity guns will explore means by which this very difficult problem of the reentry of a ballistic nose cone can be simulated on the ground.

As you know, the only way we have at the present time is to actually shoot a ballistic missile. We collect all the information we can. The designers of these missiles design them as best they know how. But the only way to really check it now is to shoot the final missile. That is when we will know whether our ideas have been correct. And we are trying to get to the position where it will be possible to try out the designs on the ground at an expense which is a very, very tiny fraction of the expense of building and shooting ballistic missiles.

The five projects I have just outlined are NACA's proposed new facilities for hypersonic research.

The remaining facilities I have not discussed in quite such detail, though I would be glad to go into any of them. I think the next one I want to talk about is the modification to the component research facility for nuclear propulsion.

You will recall about 2½ years ago a provision was made for about $5 million for a reactor which would be a source of radiation, so that

research could be done under realistic conditions of radiation, temperature, and pressure, on components for nuclear powerplants.

The design of this facility is substantially completed and construction is in progress.

In the course of our discussions with the Atomic Energy Commission while this design was going on, certain experiments were made with reactors under runaway conditions, that I am sure the chairman is familiar with. These experiments had the effect of raising somewhat the levels of possible pressures that might be generated in such a reactor, so that the design of the containment vessel required some modification.

A part of what we ask for in this amount is to take care of the additional requirements which have been imposed on us by knowledge of safety that has developed since we started the project.

We have made a very extensive study of the possible hazards. We are continuing discussions with the Atomic Energy Commission about certain details of the design of the reactor.

We have also found that in order to take care of the types of projects that we will be engaged in that it is necessary to have additional hot laboratory space. It will also be necessary to provide additional space for certain laboratory measurements and radiation studies.

One of the new considerations that has come in is the need for studying the effects of radiation on the ordinary components of the airplane.

We propose a modification and extension of the component research facility for nuclear propulsion presently under construction near Sandusky, Ohio. This research facility is for research on components for use in nuclear-powered aircraft under realistic conditions of radiation, temperature, and pressure. The design studies of the reactor show that it will provide an excellent source for high-level radiations.

Experience to date in the aircraft nuclear propulsion program has brought to light the need for extensive auxiliary equipment and laboratory facilities. The results of tests must be analyzed adequately and rapidly, making necessary the addition of more extensive facilities for handling and studying highly radioactive materials than first contemplated. A secondary reflector of beryllium is required to provide a higher and improved flux distribution in the large test holes. A large air supply and emergency power supply is needed to carry on certain types of experiments. A radiation analysis laboratory is required for the study of the effects of radiation on aircraft structures and equipment.

Recent reactor runaway experiments by the Atomic Energy Commission have resulted in a requirement for improved containment of the NACA reactor to insure safety to the surrounding area in event of an accident. The facility under construction has been designed to achieve the larger and more complex containment vessel required. Other modifications are needed to meet the requirements of the Atomic Energy Commission's Safe-Guard Committee including (1) additional retention basins, (2) additional cooling tower capacity for use as a secondary coolant for some experiments, (3) additional equipment in the primary and secondary water supply

systems to provide for safer operation and better continuity of operation, and (4) an additional independent power line to provide for continuity of operation and increased safety to the facility.

MODERNIZATION OF RESEARCH AND TECHNICAL FACILITIES

The other items of our proposed construction program are for modernizing existing research and technical facilities and for general plant and utility improvements.

It is proposed to expand the existing propulsion systems laboratory at the Lewis Laboratory by the installation of facilities to investigate the performance of engines up to Mach numbers in excess of 4.5 using the free-jet technique. The facilities recommended will also permit the more extensive use of high-energy fuels in large full-scale engine tests.

Through the years you have given us the funds to continually keep the capacity of the propulsion systems laboratory in step with developments in the size and speeds of engines. This project will keep the propulsions systems laboratory capable of meeting the problems of the engines that are now being designed.

I might remind you at this point it is always difficult to remember that we are talking about facilities that will be completed in periods from 2 to 4 years from now, and about research beginning at the completion of the facilities and appearing in aircraft and engines at a somewhat later date.

As I say, I hope later to have the opportunity to give you this picture of where we are going and where we are now. But this would have to be done off the record.

A bypass system for the Ames Laboratory unitary plan tunnel will substantially improve the usefulness and value of the 9- by 7-foot supersonic circuit of this tunnel by eliminating surging of the flow through the compressor which drives air through the two supersonic circuits of the tunnel which is encountered under some conditions, and by reducing power losses in the diffuser, resulting in some increase in maximum Mach and Reynolds numbers.

What this means is that the process of starting up this 200,000 horsepower compressor has to be done very carefully to avoid getting into conditions which would cause the flow to surge through the compressor.

It is possible by a modification of the tunnel circuit to eliminate this condition, and to greatly reduce the time required to bring the tunnel up to speed and to shut it down again.

You don't turn a 200,000 horsepower motor on and off by flicking a switch like a light switch. It has to be brought up to speed slowly. It is somewhat comparable to bringing up to speed the propulsion system on a battleship.

It is proposed that auxiliary suction be applied to the slotted test section of the Ames Laboratory 14-foot transonic tunnel for boundary layer removal. Since the design of the 14-foot transonic tunnel was completed, important advances have been made in transonic tunnel design. The application of auxiliary suction to the plenum chamber surrounding the test section has proven to be the most beneficial of recent improvements to transonic tunnels. This improvement should be applied to the 14-foot transonic tunnel without further delay.

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I would like to recall some past history for the committee. For a long time we did not know how to make a wind tunnel that would operate at the speed of sound. As a result of an invention by one of our people for which he and his associates received the Collier Trophy, the transonic wind tunnel was invented. Over the course of several years with the help of your comittee, we made this modification to several wind tunnels so that they could be run at the speed of sound. The transonic throat is a section of the tunnel that has holes or slots in its walls and which is surrounded by a closed tank. At the speed of sound, an ordinary closed wind tunnel blocks, or chokes, as we call it. With the transonic throat the air has an opportunity to go out through the holes of the wall into the external tanks and then flows in again and thus to adjust to the model making it possible to reach the speed of sound. Now, if you suck the air out of the tanks, and put it into the tunnel farther downstream, it is possible to obtain a considerable improvement both in the quality of the flow and in the speed which can be attained. This project covers such a modification.

The addition of the boundary-layer removal system will permit the tunnel's effective model size to be doubled, will increase the Mach number limit from 1.2 to 1.4, and will reduce the need for overload operation of the main drive motors over most of the tunnel's speed range.

It is proposed to improve the airflow in the 11-foot transonic tunnel circuit of the Ames unitary plan tunnel. The acquisition of new knowledge on the characteristics of transonic test sections indicates that significant improvements in the quality of the airflow can be achieved by altering the method of venting the test section and by redesigning the bypassed air reentry region at the downstream end of the test section. The proposed modernization offers the possibility of a decrease in the Mach number variations in the test section and an improvement in the airflow at the diffuser entrance of sufficient magnitude to result in a decrease in the required tunnel drive power.

It is proposed to modify the Langley Laboratory 26-inch transonic blowdown tunnel by installing an alternate 20-inch square test section to extend the maximum attainable Mach number of the facility from about 1.4 to about 4.0. This tunnel is used primarily for flutter investigations. The nature of the flutter problem at the higher Mach numbers is relatively unexplored and is urgently in need of investigation.

In addition to modernizing the research facilities just discussed, it is also necessary to modernize three of our supporting technical facilities.

The capabilities of the research vehicles used in the conduct of aeronautical research at the pilotless aircraft station at Wallops Island have exceeded the ability of the ground instrumentation to provide full coverage of a research flight. It is essential that modern instrumentation be provided to obtain urgently needed data in the hypersonic speed range. The project covers two tracking radars, telemeter, receiving equipment, an increased range Doppler system, and auxiliary equipment.

The radar equipment we are using at Wallops Island is surplus from the last war. This gives you some idea of its technical capabilities, as compared with missiles which travel at 10 times the speed of sound.

A data reduction center is required for the expansion and improvement of the automatic data-processing facilities at the Langley Aeronautical Laboratory. The complex problems involved in research at increased flight speeds and altitudes and on new aircraft configurations required for supersonic flight have greatly increased the amount of required data reduction and analysis. The new building will centralize existing data-processing facilities, improve operating efficiency, and provide on-line data-processing service for three major wind tunnels.

The increasing need for structures research at high temperature has made marginal an existing central compressor system at the Langley Aeronautical Laboratory which supplies air to several research facilities. An improved air supply for the internal flow laboratory will permit the installation of the necessary additional compressor capacity.

PLANT AND UTILITY IMPROVEMENTS

With regard to general plant and utility improvements, we propose (1) to acquire approximately 115 acres of land adjacent to the Lewis Laboratory to permit the future expansion of research facilities, (2) to install 2 boilers in the heating plant near the Langley Laboratory full-scale tunnel in place of the 8 low-pressure boilers which are nearing the end of their useful lives after more than 15 years of operation, and (3) to construct a new west area approach road at the Langley Laboratory which is necessitated by the Air Force installation of a runway extension.

Attached to this statement are two tables; one table shows the NACA construction and equipment program for fiscal year 1958 by functions, and the other table summarizes the program by laboratory.

Mr. Chairman, we urge the favorable consideration by your committee of H. R. 3377.

(The tables referred to are as follows:)

Functional summary, construction and equipment program

New facilities for hypersonic research:	
3.5-foot hypersonic tunnel (Ames)	$11,731,000
Hypersonic helium blowdown tunnel (Langley)	796,600
High-speed leg for the unitary plan tunnel (Langley)	750,000
Rocket systems research facility (Lewis)	5,700,000
Hypersonic physics test area (Langley)	1,987,900
Total	20,965,500
Expansion of facilities for nuclear research: Modifications to the component research facility for nuclear propulsion (Lewis)	5,655,000
Modernization of research facilities:	
Expansion of the propulsion systems laboratory (Lewis)	5,800,000
Bypass air system for the unitary plan tunnel (Ames)	100,000
Boundary-layer removal for the 14-foot transonic tunnel (Ames)	4,435,000
Flow improvement in the unitary plan tunnel (Ames)	255,000
Modification of the 26-inch transonic tunnel (Langley)	346,400
Total	10,936,400

Functional summary, construction and equipment program—Continued

Modernization of supporting technical facilities:	
Modernization of instrumentation (Wallops)	$2,560,000
Data reduction center (Langley)	3,067,200
Improved air supply for the internal flow laboratory (Langley)	858,000
Total	6,485,200
General plant and utility improvements:	
Land acquisition (Lewis)	300,000
Central heating system for the east area (Langley)	209,100
West area approach road (Langley)	148,800
Total	657,900
Total, fiscal year 1958 program	44,700,000

Construction and equipment program, by laboratory

Langley Aeronautical Laboratory:	
High-speed leg for unitary plan tunnel	750,000
Hypersonic physics test area	1,987,900
Data reduction center	3,067,200
Improved air supply for the internal flow laboratory	858,000
Modification of the 26-inch transonic tunnel	346,400
Central heating system for the east area	209,100
Hypersonic helium blowdown tunnel	796,600
West area approach road	148,800
Total (Langley)	8,164,000
Ames Aeronautical Laboratory:	
3.5-foot hypersonic tunnel	11,731,000
Bypass air system for the unitary plan tunnel	100,000
Boundary-layer removal for the 14-foot transonic tunnel	4,435,000
Flow improvement in the unitary plan tunnel	255,000
Total (Ames)	16,521,000
Lewis Flight Propulsion Laboratory:	
Modifications to the component research facility for nuclear propulsion	5,655,000
Expansion of the propulsion systems laboratory	5,800,000
Land acquisition	300,000
Rocket systems research facility	5,700,000
Total (Lewis)	17,455,000
Pilotless aircraft station: Modernization of instrumentation (Wallops)	2,560,000
NACA total	44,700,000

Mr. DURHAM. Thank you very much, Doctor.

Your request here, then, covers $20 million which is brought about by——

Dr. DRYDEN. Hypersonic research.

Mr. DURHAM. Hypersonic entirely?

Dr. DRYDEN. That is correct.

Mr. DURHAM. Your other project on the expansion of the nuclear research facilities—how much did that cost us to begin with, Doctor. How much did we authorize?

Dr. DRYDEN. Do you remember the amount exactly, Mr. Ulmer?

Mr. ULMER. $5,080,000 is our current allotment.

Mr. DURHAM. Then the cost has gone up almost double.

Dr. DRYDEN. No, sir, I don't think it is fair to say the cost has gone up double. About $2 million, as I recall is necessitated from considerations of safety which came largely by way of experiments by the AEC. The rest is required to provide hot laboratory space and additional space for radiation studies on aircraft structures. So the project covers an extension of the facility, as well as items required by safety considerations.

Mr. DURHAM. What are you using that primarily for, all types of metallurgical research?

Dr. DRYDEN. Essentially material and component research; yes, sir.

Mr. DURHAM. And the modernization of research facilities; those are for facilities which have already been authorized heretofore?

Dr. DRYDEN. Yes, sir. They are authorized and built. This program will keep them modern, by extending their speed ranges or by extending their capabilities in other respects.

Mr. DURHAM. Then we could say most of this request for authorization becomes necessary due to the fact that we have moved into higher speeds——

Dr. DRYDEN. That is correct.

Mr. DURHAM. And more critical metallurgical problems?

Dr. DRYDEN. Yes, sir.

Mr. DURHAM. Due primarily to speed?

Dr. DRYDEN. Yes, sir.

Mr. DURHAM. Mr. Cole, do you have any questions?

Mr. COLE. Do the NACA have any unused authorizations or appropriations?

Dr. DRYDEN. No, sir. We keep them current every year.

Mr. COLE. Do you come to Congress every year for authority?

Dr. DRYDEN. Every year, sir.

Mr. COLE. I thought it was every other year.

Dr. DRYDEN. Every year, sir.

Mr. COLE. Of what does this process of screening the projects by your committee consist?

Dr. DRYDEN. This program begins with the projects submitted by our research laboratories. This year they submitted items which totaled I think about $130 million. This then is reviewed in our headquarters office. I think we came down to something in the order of $60 million. The program was then presented to the facilities panel of the NACA, the 17 men appointed by the President. General Doolittle, who is now Chairman of the Committee, has been for many years the chairman of this facilities panel. They reviewed the projects one by one, made some changes in priority, and some changes in scope.

The program then went to the Bureau of the Budget and what you have is the result of their review.

Mr. COLE. How much did the budget reduce it?

Dr. DRYDEN. From about $60 million to $44 million.

Mr. COLE. Can you indicate the items that they omitted?

Dr. DRYDEN. Let me see.

We can put those in the record. I do not have the list with me.

Mr. COLE. It could not have been very important if you do not remember them.

Dr. DRYDEN. Most of them were relatively small improvement items although there were some large ones omitted.

Mr. COLE. Pick out the large ones.

Dr. DRYDEN. I believe there were only two large ones: a structural research facility and improvements to the 4-foot tunnel, both at the Langley Laboratory.

Mr. COLE. Is not this new authority which you are seeking here to give you permission to use any of this $44 million to repair anything that may break down?

Dr. DRYDEN. This really came as a result of a suggestion——

Mr. COLE. I said isn't this new authority——

Dr. DRYDEN. Yes, sir; this is new.

Mr. COLE. Now, where did it come from?

Dr. DRYDEN. It came from our discussions with the Bureau of the Budget. When we have any serious failure of equipment, if the amount is any appreciable sum, say over $100,000, we find great difficulty in providing funds for repairs without delaying or slowing down our research effort. This language is proposed as a method of dealing with these emergencies.

Take our very large wind tunnels. Suppose we had a major breakdown. Under the present circumstances, we could not do a thing, unless Congress was in session and we came to Congress and got the money. The proposed language is a suggested method of dealing with that problem.

Mr. COLE. The only illustration you have used is the instance of a $100,000 repair bill.

Dr. DRYDEN. Yes, sir.

Mr. COLE. That is a long, long ways short of $44 million, for which you are now asking.

Dr. DRYDEN. I certainly would not intend using $44 million for that purpose, even though technically, the language would so permit.

Mr. COLE. That is the way it is worded. It says those are the funds and the funds total $44 million.

Dr. DRYDEN. There should be some reasonable limitation on the amount; we would have no objection whatever to any reasonable limitation.

Mr. COLE. I don't know why there should not be a general authorization for you to make any repairs which are needed. Why do you have to have it this year?

Dr. DRYDEN. If a major breakdown occurs this is a way in which we could stop a new project, use the money for the repairs and then come back to you. If we thought repairing the wind tunnel was more important, this language would allow the Chairman of NACA, with the approval of the Bureau of the Budget, to do that. With so many large research facilities in operation, this is suggested as a matter of insurance against having an important facility idle for a substantial period of time.

Mr. COLE. I would suggest, Mr. Chairman, the authority for the use of funds for repairs should not be tied to authority for the construction of the particular projects.

Instead it should be independent.

Of course, you should have the authorization. But it seems to me questionable whether they should be tied together. And certainly if

they are to be tied together the authority should not extent to the total amount of the authorization.

Dr. DRYDEN. I agree fully about the suggestion for a reasonable limitation on the amount that could be used for emergency repairs.

Mr. DURHAM. If the item is great enough to request authorization for it, I should think that, after all, you would want to complete that, and that there ought to be some other way of taking care of the repairs.

Dr. DRYDEN. Mr. Durham, you remember these Unitary Plan wind tunnels cost about 35 or 40 million dollars apiece. The electric motors and compressors on those tunnels are a substantial part of that cost. They are engaged in working with current military aircraft and missiles. If one of these tunnels breaks down, we just don't have money available for major repairs. The chairman of the committee and the Director of the Budget might consider it is much more essential to get that tunnel back in operation promptly than it might be to continue work on some facility on which construction was just started. This is the problem.

Mr. DURHAM. Well, that certainly applies to other departments of the Government, also. How do they handle that on repairs?

Dr. DRYDEN. I think that most departments that have facilities of this magnitude have much higher operating budgets and therefore have more flexibility. Over 75 percent of our budget, I think, is for personnel. We do not have large sums of money available for such major repairs. At present we would have to shut the tunnel down, and start the procedure for requesting authorization and appropriations. If Congress were in session we probably would not have very much difficulty in an emergency. If Congress were not in session, there would be no way for us to proceed. The proposed language is a means of buying time.

Mr. DURHAM. Would you give us at this point the number of personnel employed by the NACA?

Dr. DRYDEN. It is about 7,800, sir.

Mr. KELLEHER. In conditions such as this in other departments normally they have substantial maintenance and operation funds, which they would use in a situation like this. But they would not have a breakdown of a facility worth this much because almost no one else has that type of facility.

Mr. DURHAM. I realize a wind tunnel costs $35 million, and if there is nothing you can do with it, and you have to let it stand there a year, that would, I think, be very bad business. There ought to be some way to work it out.

Dr. DRYDEN. This is a suggested method of handling this potentially serious problem of unanticipated breakdowns.

Mr. DURHAM. Yes. I agree you should be able to handle it, but it may raise some question in Congress.

Mr. DURHAM. Mr. Bennett?

Mr. BENNETT. No questions.

Mr. DURHAM. Mr. Lankford?

Mr. LANKFORD. How did you arrive at the figure of $300,000 for this land acquisition?

Dr. DRYDEN. This [indicating] is our laboratory at the edge of the Cleveland Airport. The runways, as you see, are those of the Municipal Airport of Cleveland. The area outlined here in red is our present site. This is park land running through the middle. Here is an

adjoining tract of land which as yet has had very little residential development.

In the course of time that land would undoubtedly be all built up with houses. There would be no place for our laboratory to expand. So it appears prudent to us to provide for the future at a relatively low cost, and this is the tract that is talked about.

Do you know, Mr. Ulmer, the source of this estimate?

Mr. ULMER. I believe it is an estimate based on sales of comparable land in the area.

Mr. DURHAM. Have you got an option on it?

Mr. ULMER. No, sir; no option.

Mr. DURHAM. When you put this in here that will be the price of it?

Mr. LANKFORD. $2,608.70 an acre.

Mr. COLE. Isn't it farmland?

Dr. DRYDEN. No, sir. There is one part of it that is owned by someone living in one of these big houses.

Mr. COLE. I know somebody must own it, of course, but is it farmland?

Dr. DRYDEN. No, I think not. It is occupied by 3 or 4 homes with large surrounding grounds. It seems clear that this area will be built up rapidly. If I had given you a wider field of view you would see the residential areas coming up in this area [indicating].

Mr. DURHAM. We had this expansion up before, as I recall it, Doctor.

Mr. KELLEHER. No, sir.

Dr. DRYDEN. No, sir; not this particular one.

Mr. LANKFORD. That is just really a sort of guesstimate, isn't it, Doctor?

Dr. DRYDEN. Sir?

Mr. LANKFORD. You have no options or anything like that?

Dr. DRYDEN. No, sir.

Mr. LANKFORD. You do not have any real idea what the value of the land is?

Dr. DRYDEN. Only by what surrounding land has been sold for.

Mr. KELLEHER. They have no authority to get options and pay a consideration for them.

Mr. BENNETT. You are not going to make any effort to get that park land in between?

Mr. ULMER. The park land will remain park land.

Dr. DRYDEN. It is a very deep gully with a stream down at the bottom.

Mr. ULMER. This park land [indicating] is owned by the city of Cleveland. It is presently a park, and there is no intention of changing that at all.

Mr. COLE. Presently a what?

Dr. DRYDEN. Presently a park, sir, a municipal park.

Mr. COLE. How are you going to use it, by going around?

Mr. ULMER. The site we propose to acquire has access through this road [indicating].

Mr. BENNETT. It is not connected?

Mr. ULMER. It is not contiguous, but it is connected by the same road that comes into this area of our laboratory.

Mr. BENNETT. It just seems to me it might be a good idea, where you have that salient of land there, you may have that land so you could fence it if you decided to fence it.

Mr. ULMER. It is possible the economics of the situation would make it desirable to put a small bridge across here, perhaps. We have not worked that out. But that is a possibility.

Dr. DRYDEN. And I want to be quite clear with the committee—we have nothing at the moment that we plan to put on this land. Our experience has been that as the community builds up around you the cost of land goes up, and then your only alternative is a secondary site. Operating expenses increase every time you do that.

Mr. DURHAM. I believe you said, Doctor, two items are not in this year's budget figures.

Dr. DRYDEN. I should say that the Bureau of the Budget has deferred the financing of the approach road, and the data reduction center, both at the Langley Laboratory.

They approved our asking for the full amount of the authorization, but in the current program for reducing expenditures, they did not approve of our seeking funds for those two items at this time.

Mr. DURHAM. What is your proposed request to the appropriations Committee this year for operations; for salaries and expenses, not for construction.

Dr. DRYDEN. About $76 million.

Mr. DURHAM. $76 million?

Dr. DRYDEN. Yes, sir.

Mr. DURHAM. I can say sincerely, I think if all the Government agencies had done the job you people have done, at the cost you have done it at, we could reduce the budget very much further. I have always felt this was at the heart of building an Air Force and you have done an excellent job in keeping up with research and development in aircraft.

Dr. DRYDEN. There are so many very interesting accomplishments and prospective accomplishments that we could tell you about sometime when you have time.

Mr. DURHAM. I think the committee would like to have that, particularly on nuclear power, because that is one thing we are deeply interested in. We are having some difficulties and troubles with it at the present time and it is one of those things that Mr. Cole and I and other members of the committee are deeply interested in.

Is there anyone else to testify this morning?

Mr. KELLEHER. May I ask one question, Mr. Chairman, please?

Mr. DURHAM. Surely.

Mr. KELLEHER. Dr. Dryden, at the bottom of page 5 and top of page 6 of your statement you say the project entitled "High Speed Leg for the Unitary Plan Tunnel" covers construction of two fixed nozzles previously included as part of the project approved in the fiscal year 1957 construction program.

Dr. DRYDEN. Yes.

Mr. KELLEHER. Then they were deleted because you had to stay within your budgetary——

Dr. DRYDEN. We did not get the total funds appropriated that we asked for.

Mr. KELLEHER. Right. I understand that. My question is this: Are we authorizing again something that has been authorized before?

Mr. ULMER. May I speak to that, Mr. Kelleher?

Mr. KELLEHER. Yes, sir.

Mr. ULMER. Generally speaking, you are correct except that the 1957 authorization did not become law. It passed the House, but did not pass the Senate. So the item has been included in this authorization.

Mr. KELLEHER. This will be the only one for bookkeeping purposes then.

Mr. DURHAM. Are there any further questions?

Without objection, the bill is reported favorably to the full committee.

Thank you very much, Doctor.

The committee is adjourned.

(Whereupon, at 11:05 a. m., the committee adjourned to meet at the call of the Chair.)